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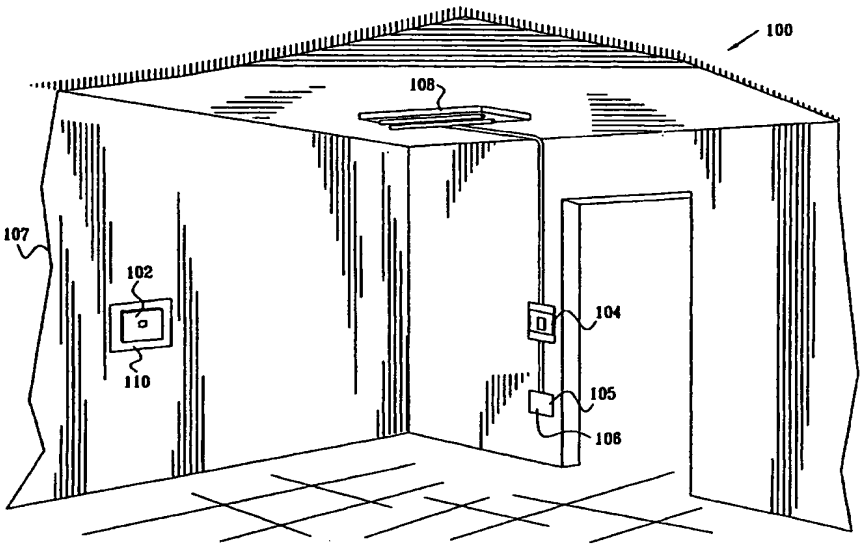

(57) Abstract: An electrical switching system (100), including a transmitting unit (102) which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user. The switching system includes a receiver assembly (104) which is configured to be retrofitted to a non-incandescent load (108) remote from the transmitting unit, so as to toggle the load between an "on", a dim, and an "off" state responsive to the actuating signal.

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REMOTE SWITCHING AND ACTUATION OF ELECTRICAL DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Applications No. 60/164,983 filed 11 November, 1999, No. 60/166,478 filed 19 November, 1999, No. 60/179,027 filed 31 January, 2000, and No. 60/187,005 filed 3 March, 2000, which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to actuation of electrical devices, and specifically to a remote-controlled switching system that is operable from one or more locations.

BACKGROUND OF THE INVENTION

Hard-wired wall mounted switching systems which are operable from one or more locations for switching of an electrical circuit are well known in the art. Typically, these systems employ a number of switches coupled together, such that the operation of one switch will reverse the energization state of the load between an on and off state.

Addition of wall mounted switches beyond those originally fitted, is generally a costly and disruptive procedure. New wiring channels must be cut or existing channels must be opened up, requiring subsequent refinishing of the wall surface. In addition, building codes may place restrictions on the way that new switches are connected to the existing system. Therefore, it would be beneficial to have a wireless switching system that could easily be retrofitted to an existing system for operating electrical devices from one or more locations.

The operation of electrical devices by remote control is well known in the art. However, remote control capabilities are typically built-in to specific electric devices, such as televisions or air-conditioners, at the time of manufacture. It would be desirable to have non-specific remote control capabilities which could be applied according to the needs of the user.

U.S. Patents 5,239,205, 5,340,954 and 5,818,128 to Hoffman et al., whose disclosures are incorporated herein by reference, describe a wireless multiple position switching system for controlling the application of power to a load device from a plurality of remote locations. The switching system includes a power source, a load device, a master toggle switch and one or more slave toggle switches. Each slave toggle switch generates an

electromagnetic switching signal which changes the state of the master switch. The master switch is connected in series with the power source and the load device and controls the power to the load device in response to the switching signal from the slave switch, or by actuation of its own toggle. The system is designed for incandescent lights having a lighting load between 25-500 watts, and will not work with fluorescent lights, lights with fans, or other electrical appliances. The system is requires decoupling of the power source from the incandescent light, so that when the light is hard-wired to the power source the system should be installed by an experienced electrician.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide an improved switching system for operating electrical devices by remote control.

It is a further object of some aspects of the present invention to provide an improved switching system for electrical devices which can be easily retrofitted to existing electrical circuitry.

In some preferred embodiments of the present invention, a retrofit switching system comprises one or more transmitter units and a receiver assembly. The receiver assembly is retrofitted in series between an existing power source and an existing load, most preferably by minimal disruption to an existing circuit between the source and the load. The one or more transmitter units are positioned at respective locations remote from the receiver assembly. On actuation, each transmitter sends a switching signal to the receiver assembly. The receiver assembly responds to the switching signal by reversing an energization state of the load whenever the signal is received. Preferred embodiments of the present invention thus enable an existing system which is not remotely actuated to be changed to a remotely controlled system, without appreciable disruption to the existing system.

In some preferred embodiments of the present invention, the one or more transmitter units are fixed, preferably by wall mounting, at respective locations. Alternatively or additionally, at least some of the one or more transmitter units are mobile.

In some preferred embodiments of the present invention, the receiver assembly is comprised in a plug connected to an electric cord. In other embodiments of the present invention, the receiver assembly is inserted into an electrical socket.

In some preferred embodiments of the present invention, the receiver assembly is comprised in a ballast of a fluorescent lamp, either as a retrofit attachment to an existing ballast, or as part of a replacement for the existing starter or ballast. Alternatively, the receiver assembly is implemented as an insert positioned in either end socket of the fluorescent lamp.

In some preferred embodiments of the present invention the receiver assembly replaces a starter of a fluorescent lamp. In this case the receiver comprises a switch which activates so as to generate high voltage pulses, as are generated by the starter, in order to start the fluorescent lamp operating. To switch the lamp off, the receiver uses the switch to short the lamp, so as to extinguish fluorescing gas in the lamp.

In some preferred embodiments of the present invention, the receiver assembly comprises a decoder for identifying the digital code of a specific transmitter or plurality of

transmitters. In other preferred embodiments of the present invention, the decoder comprises a learning mode for new or different operation codes.

In some preferred embodiments of the present invention, the system comprises a regulator for regulating electrical current and/or voltage flowing to the load, thereby extending the life of the load, for example when the load is a light bulb.

In some preferred embodiments of the present invention, a warning device associated with the receiver assembly indicates whether a load, such as a lamp. has burned out or is about to burn out. In other embodiments of the present invention, the receiver assembly disconnects the circuit when no load is present or has burned out. The receiver assembly thus acts as a safety device, reducing the possibility of electrical shock when changing or inserting a new load.

In some preferred embodiments of the present invention, the receiver assembly comprises a transmitter which transmits parameters, such as electrical parameters related to the status of the load, to a user of the load.

In some preferred embodiments of the present invention, the receiver assembly is attached at an intermediate position on a electric cable. In another embodiment of the present invention, the receiver assembly is a substantially cylindrical unit formed around the electric cord.

There is therefore provided, according to a preferred embodiment of the present invention, an electrical switching system, including:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a non-incandescent load remote from the transmitting unit, so as to toggle the load between an "on" and an "off" state responsive to the actuating signal.

Preferably, the transmitting unit is mounted in a fixed position.

Alternatively, the transmitting unit includes a mobile transmitting unit.

Preferably, the transmitting unit includes a plurality of transmitting units, at least some of which are mounted in fixed positions.

Preferably, the actuating signal includes an electromagnetic signal.

Alternatively, the actuating signal includes an acoustic signal.

Preferably, the actuating signal includes one or more codes, and the receiver assembly includes a decoder which decodes the one or more codes so as to toggle the load.

Further preferably, the decoder includes a memory which stores the one or more

codes of the actuating signal.

Preferably, the decoder includes a learning module which, responsive to the actuating signal, stores the one or more codes in the memory.

Preferably, the transmitting unit includes one or more power sources selected from a group consisting of a battery, a mains power supply, a piezoelectric film, a piezoelectric crystal, an electrical induction device, a static electricity device, capacitative charge from an operator of the transmitting unit, and a mechanically operated dynamo, and wherein the one or more power sources power the transmitting unit.

Preferably, the non-incandescent load includes circuitry coupling the load to a power source.

Further preferably, the circuitry includes a circuit element selected from a group consisting of a cable coupled to the load, a socket coupled to the cable, a plug coupled to the socket, and a switch coupled to the cable.

Preferably, the non-incandescent load includes a fluorescent lamp, wherein the fluorescent lamp includes a lamp accessory selected from a group consisting of one or more sockets, a starter, and a ballast, and wherein the receiver assembly is retrofitted to the lamp accessory.

Preferably, the receiver assembly is adapted to generate a voltage to start the fluorescent lamp.

Further preferably, the receiver assembly is adapted to short-circuit the lamp accessory, so as to switch off the fluorescent lamp.

Preferably, the non-incandescent load includes at least one load selected from a group consisting of a fluorescent lamp, a reactive device, and a resistive device.

There is further provided, according to a preferred embodiment of the present invention, an electrical switching system, including:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a load remote from the transmitting unit so as to toggle the load between an "on" and an "off" state responsive to the actuating signal, and which is adapted to detect a status of the load and to provide an indication of the status to the user.

Preferably, the status of the load includes a state selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average

demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load, and the receiver assembly is adapted to adjust a power source to the load responsive to the state.

Preferably, the load includes circuitry coupling the load to a power source, and the status of the load includes a fault in the circuitry.

Preferably, the receiver assembly includes a sound-emitting device, and the indication is an audible warning generated by the device.

Further preferably, the receiver assembly includes a light-emitting device, and the indication is a visible warning generated by the device.

Preferably, the receiver assembly includes a radio-frequency (RF) transmitter which transmits an RF signal indicative of the status of the load.

Preferably, the receiver assembly includes a detector which is adapted to transmit to the user one or more parameters selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

There is further provided, according to a preferred embodiment of the present invention, an electrical switching system, including:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a load remote from the transmitting unit so as to toggle the load between an "on" and an "off" state responsive to the actuating signal, and which is adapted to detect a status of the load and to alter a parameter of electrical power supplied to the load responsive to the status.

Preferably, the status of the load includes a change in status of the load, and the parameter of electrical power includes either a current through the load or a voltage across the load, which parameter is regulated.

Preferably, the system includes regulating the parameter so as to lengthen a lifetime of the load.

There is further provided, according to a preferred embodiment of the present invention, a method for switching an electrical system, including:

retrofitting a receiver assembly to circuitry including a non-incandescent load;

transmitting an actuating signal receivable by the receiver assembly from a transmitting unit remote from the receiver assembly; and

toggling the load between an "on" and an "off" state responsive to the actuating signal.

Preferably, the transmitting unit is mounted in a fixed position.

Alternatively, the transmitting unit is mobile.

Preferably, the transmitting unit includes a plurality of transmitting units, at least some of which are mounted in fixed positions.

Preferably, transmitting the actuating signal includes transmitting an electromagnetic signal.

Alternatively, transmitting the actuating signal includes transmitting an acoustic signal.

Preferably, transmitting the actuating signal includes transmitting one or more codes, and toggling the load includes decoding the one or more codes.

Preferably, retrofitting the receiver assembly includes providing a memory in the receiver assembly and storing the one or more codes in the memory.

Preferably, storing the one or more codes includes learning the one or more codes responsive to the actuating signal.

Preferably, transmitting the actuating signal includes powering the transmitting unit from one or more power sources selected from a group consisting of a battery, a mains power supply, a piezoelectric film, a piezoelectric crystal, an electrical induction device, a static electricity device, capacitative charge from an operator of the transmitting unit, and a mechanically operated dynamo.

Preferably, the circuitry includes a circuit element selected from a group consisting of a cable coupled to the load, a socket coupled to the cable, a plug coupled to the socket, and a switch coupled to the cable.

Preferably, the non-incandescent load includes a fluorescent lamp, wherein the fluorescent lamp includes a lamp accessory selected from a group consisting of one or more sockets, a starter, and a ballast, and wherein retrofitting the receiver assembly comprises retrofitting the unit to the lamp accessory.

Preferably, toggling the load includes generating a voltage to start the fluorescent

lamp.

Further preferably, toggling the load includes short-circuiting the lamp accessory, so as to switch off the fluorescent lamp.

Preferably, the non-incandescent load includes at least one load selected from a group consisting of a fluorescent lamp, a reactive device, and a resistive device.

There is further provided, according to a preferred embodiment of the present invention, a method for controlling an electrical system, including:

retrofitting a receiver assembly to circuitry including a load;

transmitting an actuating signal receivable by the receiver assembly from a transmitter remote from the receiver assembly;

toggling the load between an "on" and an "off" state responsive to the actuating signal;

detecting a status of the load; and

providing an indication of the status to a user.

Preferably, detecting the status of the load includes detecting a state selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load, and toggling the load includes disconnecting a power source from the load responsive to the detected state.

Preferably, detecting the status includes detecting a fault in the circuitry.

Preferably, the receiver assembly includes a sound-emitting device, and providing the indication includes generating an audible warning from the device.

Preferably, the receiver assembly includes a light-emitting device, and providing the indication includes generating a visible warning from the device.

There is further provided, according to a preferred embodiment of the present invention, a method for controlling an electrical system, including:

retrofitting a receiver assembly to circuitry comprising a load;

transmitting an actuating signal receivable by the receiver assembly from a transmitter remote from the receiver assembly;

toggling the load between an "on" and an "off" state responsive to the actuating signal;

detecting a status of the load; and

altering a parameter of electrical power supplied to the load responsive to the status.

Preferably, detecting the status of the load includes detecting a change in status of the load, and altering the parameter of electrical power includes regulating a current through the load.

Further preferably, detecting the status of the load includes detecting a change in status of the load, and altering the parameter of electrical power includes regulating a voltage across the load.

Preferably, altering the parameter includes regulating the parameter so as to lengthen a lifetime of the load.

There is further provided, according to a preferred embodiment of the present invention, an electrical switching system, including:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be coupled to a load including an electrically excitable gas remote from the transmitting unit, so as to toggle the load between a plurality of states responsive to the actuating signal.

Preferably, the load includes a fluorescent tube within which the electrically excitable gas is contained.

Preferably, the receiver assembly is coupled to the fluorescent tube as a replacement for a starter of the fluorescent tube.

Preferably, the receiver assembly includes a switch, and the receiver assembly is adapted to toggle the load by operating the switch so as to short-circuit the fluorescent tube.

Preferably, the receiver assembly includes a switch and a detector which detects one or more electrical parameters preventing the fluorescent tube from starting, and the receiver assembly is adapted to operate the switch when the detector indicates that the one or more electrical parameters will not cause the tube to start.

Preferably, the one or more electrical parameters include a voltage across the switch being approximately zero volts.

Preferably, the receiver assembly includes a switch and a detector which detects one or more electrical parameters which start the fluorescent tube, and the receiver assembly is adapted to operate the switch when the detector indicates that the one or more electrical parameters will cause the tube to start.

Preferably, the one or more electrical parameters include a voltage across the switch

being approximately a maximum voltage received from a power supply.

Preferably, the fluorescent tube includes a heating filament and a starter, and the receiver assembly is coupled to the heating filament.

Preferably, the starter is replaced by a device adapted to act as a short-circuit of the fluorescent tube.

Preferably, the plurality of states include two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, and one or more reduced-energy states.

Preferably, the receiver assembly includes a status transmitter unit which is able to transmit parameters corresponding to a status of the receiver assembly.

Preferably, the status includes one or more parameters selected from a group including a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

Preferably, the receiver unit includes a status transmitter unit which is able to transmit parameters corresponding to a status of the load.

Preferably, the status includes one or more parameters selected from a group including a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a retrofit remote switching system, in accordance with a preferred embodiment of the present invention;

Fig. 2 is a schematic diagram of components of a transmitting unit comprised in the system of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 3 is a schematic diagram of components of a receiver assembly comprised in the system of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 4 is a schematic diagram showing locations for the receiver assembly of Fig. 3, in accordance with a preferred embodiment of the present invention;

Fig. 5 is an exploded schematic view of a fluorescent lamp in a housing, in accordance with a preferred embodiment of the present invention;

Fig. 6 is a schematic diagram of a receiver assembly used with a fluorescent tube, in accordance with an alternative preferred embodiment of the present invention;

Fig. 7 is a flowchart showing a method for switching the tube of Fig. 6 "on" using a receiver assembly, in accordance with a preferred embodiment of the present invention;

Fig. 8 is a flowchart showing a method for switching the tube of Fig. 6 "off" using a receiver assembly, in accordance with a preferred embodiment of the present invention;

Fig. 9 is a schematic diagram of a receiver assembly used with a fluorescent tube, in accordance with a further alternative preferred embodiment of the present invention; and

Fig. 10 is a schematic diagram of a receiver assembly used with a fluorescent tube, in accordance with an alternative preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 is a schematic view of a retrofit remote switching system 100, in accordance with a preferred embodiment of the present invention. A transmitting unit 102 is activated and sends a signal to a receiver assembly 104, remote from the transmitting unit, which receiver assembly is connected in series with an existing electrical power source 106 and an existing load 108. On receipt of the signal, system 104 toggles load 108 between an "on" and an "off" state by connecting and disconnecting source 106 from the load. In preferred embodiments of the present invention, load 108 comprises substantially any non-incandescent electrical load, such as a fluorescent lamp, a reactive device such as a motor, a resistive device such as a space heater, or a device comprising at least one of these, which is at least partly powered by an external power source. Furthermore, load 108 may comprise a plurality of electrical devices described above, which devices are collectively powered by source 106. Receiver assembly 104 is installed at any convenient location so that it is in series with load 108 and source 106. For example, load 108 is a fluorescent lamp, source 106 comprises a main AC power supply line, and receiver assembly 104 is retrofitted to an existing switch box 105 which couples source 106 to load 108.

Fig. 2 is a schematic diagram of components of transmitting unit 102, in accordance with a preferred embodiment of the present invention. Transmitting unit 102 is preferably attached directly to a wall 107 (Fig. 1). Alternatively, transmitting unit 102 is retrofitted to an existing structure 110 such as a wall socket, wherein there is preferably an existing electrical supply. The transmitting unit comprises a switch 112 and a transmitter 114. Transmitter 114 generates a signal which is transmitted to receiver assembly 104 whenever switch 112 is actuated. Most preferably, an encoder 113 comprised in unit 102 encodes the signal from transmitter 114 to a switching signal. The switching signal is preferably generated from electromagnetic radiation such as radio frequency, or non- diffused or diffused infrared radiation, as is known in the art. Alternatively, the switching signal is generated by non-electromagnetic radiation such as acoustic or ultrasonic signals or signals via a power line. The switching signal optionally comprises information corresponding to a digital code, described in more detail hereinbelow. Optionally, a plurality of transmitting units 102 are fixed at a respective plurality of switching locations remote from receiver assembly 104, preferably on wall 107. Alternatively or additionally, at least one transmitter unit 102 is a mobile unit.

Transmitter unit 102 is powered by a power source 116. Power source 116 may be the mains power supply and/or a battery. Alternatively or additionally, power source 116

comprises one or more other power sources known in the art, such as a piezoelectric film, a piezoelectric crystal, an electrical induction device, a static electricity device, capacitative charge from a person or object operating the transmitter, or a mechanically operated dynamo.

Fig. 3 is a schematic diagram of components of receiver assembly 104, in accordance with a preferred embodiment of the present invention. The receiver assembly comprises a receiver 202 capable of receiving an electromagnetic or other type of signal transmitted by transmitter unit 102. The receiver assembly also comprises a switch 204, which is in either an ON state in which a wire 208 from load device 108 is connected to a wire 206 from power source 106, or in an OFF state in which the load device is disconnected from the power source. Switch 204 toggles between its states whenever receiver 202 receives a signal from transmitter unit 102. Optionally, switch 204 may also be toggled manually without a switching signal, by suitable means known in the art.

Receiver 202 is preferably powered by the mains power supply via wire 206. Additionally or alternatively, receiver 202 is powered by a battery 212. In some preferred embodiments of the present invention, the receiver unit comprises a logic system 209. System 209 comprises a decoder 210 for decoding a digital code incorporated by transmitter unit 102 in the switching signal. Most preferably, logic system 209comprises a memory 213 for storing one or more digital codes. Optionally, logic system 209 comprises a learning module 214, which when activated stores one or more codes characteristic of one or more transmitter units 102 in memory 213, thus enabling receiver 202 to be operated by each of the one or more transmitter units 102 transmitting the stored codes.

Fig. 4 is a schematic diagram showing locations for receiver assembly 104, in accordance with a preferred embodiment of the present invention. A lamp 308, most preferably a fluorescent lamp, is powered from a wall socket 302, via an electric cord 304 connecting to a plug 301 in the socket. System 104 may be positioned in substantially any circuit element providing power to lamp 308, for example, in wall socket 302, in plug 301, between the plug and the socket, or along electric cord 304. If system 104 is positioned along cord 304, it is preferably implemented as a substantially cylindrical unit 306 formed around the electric cord and inserted into the cord at a position 303 intermediate between lamp 308 and plug 301. As described below in more detail, system 104 may also be positioned in a housing 310 of lamp 308, or as an insert to the lamp. In all cases wherein receiver assembly 104 is positioned in a circuit element providing power to lamp 308, the receiver unit is connected in series with a power source 312 and the lamp. It will be

appreciated that if lamp 308 is an illumination device different from a fluorescent lamp, unit 104 may be connected to a housing of the lamp, or to other parts of the lamp, such as a base of the lamp.

Fig. 5 is an exploded schematic view of fluorescent lamp 308 in housing 310, in accordance with a preferred embodiment of the present invention. Fluorescent lamp 308 comprises lamp accessories including a fluorescent tube 404, a starter 408, and a lamp ballast 410, connected and operating by methods known in the art. Most preferably, receiver assembly 104 is installed in lamp ballast 410. Ballast 410 is then used to replace an existing ballast of lamp 308. Further alternatively, receiver assembly 104 is retrofitted to lamp ballast 410.

Fig. 6 is a schematic diagram of a receiver assembly 500 used with a fluorescent tube 502, in accordance with an alternative preferred embodiment of the present invention. Receiver assembly 500 replaces a starter 504 which conventionally generates high voltage in order to start tube 502 fluorescing. Receiver assembly 500 comprises a receiver/decoder unit 506, which, except as described hereinbelow, functions in a substantially similar manner and comprises substantially similar components as receiver assembly 104. Receiver unit 506 actuates a logic starter and turn-off unit 508 which toggles a starter-replacement switch 510 between "on" and "off" states. Unit 508 is actuated on receipt of a transmission signal from transmitter unit 102. A detector 516, most preferably comprising a voltage detector, is able to measure electrical parameters of switch 510, including the instantaneous voltage across the switch. Detector 516 is also able to detect if tube 502 is in a fluorescent "on" state, or in a non-fluorescent "off" state, by methods known in the art, for example, by measuring one or more electrical parameters of the power supplied to tube 502. Most preferably, electrical parameters measured by detector 516, in order to perform their respective functions, comprise at least some of the parameters: voltage, current, frequency, frequency component, time of application of the power, and combinations of these parameters. A power supply 507 with power derived from a power line preferably operates receiver 506 and unit 508. Alternatively or additionally, power supply 507 comprises a battery.

Fig. 7 is a flowchart showing a method for switching tube 502 "on" using receiver assembly 500, in accordance with a preferred embodiment of the present invention. In an initial step, while tube 502 is off, receiver unit 506 receives a signal from transmitter unit 102. Unit 506 actuates unit 508, which closes starter-replacement switch 510 for a time of the order of 1 second, so as to charge a ballast 512 in series with tube 502, and so as to heat

filaments of the tube. Unit 506 then opens switch 510, most preferably at a time when the absolute voltage across the switch, as detected by detector 516, or as determined by another method known in the art, is at or close to a maximum instantaneous voltage across tube 502. By opening switch 502 at this time, ballast 512 generates a high voltage, which turns tube 502 on. Alternatively or additionally, tube 502 is turned on by measuring a current through the tube, by methods known in the art.

In the event that tube 502 does not turn on after switch 510 has been closed then opened, this is detected by detector 516. The cycle of opening and closing switch 510 is most preferably repeated until the tube does turn on, as detected by detector 516. Alternatively, cycling is repeated for a fixed number of times, for example ten times.

Fig. 8 is a flowchart showing a method for switching tube 502 "off" using receiver assembly 500, according to a preferred embodiment of the present invention. In an initial step, while tube 502 is on, receiver unit 506 receives a signal from transmitter unit 102. Unit 506 actuates unit 508, which preferably closes switch 510 for a time of between periods corresponding to approximately a quarter of a cycle of the power supply to tube 502 and approximately one hundred cycles of the power supply. Optionally, switch 510 is closed in a vibratory pattern. It will be appreciated that closing switch 510 while tube 502 is "on" reduces the voltage across the tube below an ionization voltage thereof, so that tube 502 ceases fluorescing. Unit 506 then opens switch 510, preferably at a time when the absolute voltage across the switch, as detected by detector 516 or as determined by another method known in the art, is low enough so that tube 502 does not turn back on. Most preferably, the absolute voltage is close to zero. By opening switch 502 at this time, ballast 512 does not generate a reverse high voltage or current, so that tube 502 does not turn on.

In the event that tube 502 does not turn or remain off after switch 510 has been closed then opened, this is detected by detector 516. The cycle of opening and closing switch 510 is repeated as described hereinabove until the tube does turn and remain off, as detected by detector 516. Alternatively, cycling is repeated for a fixed number of times, for example ten times.

Fig. 9 is a schematic diagram of a receiver assembly 600 used with a fluorescent tube 602, in accordance with a further alternative preferred embodiment of the present invention. Receiver assembly 600 is preferably implemented as an insert 604, most preferably a ring insert, which is fitted between either end 606 of fluorescent tube 602 and a respective socket holding the tube. A starter 608 for tube 602 most preferably comprises a bimetallic strip starter, and starting voltage for tube 602 is supplied by a conventional

ballast 610 from a power supply 611.

Receiver assembly 600 comprises a receiver/decoder unit 612, which, except as described hereinbelow, functions in a substantially similar manner and comprises substantially similar components as receiver assembly 104. Receiver/decoder unit 612 receives signals from transmitter unit 102, and on receipt of the signals, receiver unit 612 actuates a logic starter unit 614 which toggles a switch 616 between "on" and "off" states. Assembly 600 further comprises a power supply 618 which powers units 612 and 614.

Bimetallic starter 608 operates by acting, during periods when tube 602 is in a steady state of being "on" or "off," as a current conductor. When changing state, starter 608 changes briefly to acting as a poor conductor, so that when tube 602 in a conventional system is switched from off to on, ballast 610 generates a high voltage. In preferred embodiments of the present invention, when tube 602 is in an off state, a small current is drawn via starter 608 so as to operate power supply 618. The current is small enough so that the starter does not change to its poor conductor state. When tube 602 is in an on state, power supply 618 is operated via a small load, in series with tube 602, comprised in the power supply. Thus receiver assembly 600 is always powered. It will be appreciated that switch 616 toggles tube 602 between on and off states on receipt of signals from transmitter 102.

Fig. 10 is a schematic diagram of a receiver assembly 700 used with a fluorescent tube 702, in accordance with an alternative preferred embodiment of the present invention. A conventional starter is replaced by a device 706 which acts as a short-circuit between connectors 708 which connect to the conventional starter. Receiver assembly 700 is implemented as an insert 704, most preferably a ring insert, which is fitted or retrofitted between either end 710 of fluorescent tube 702 and a respective socket holding the tube.

Assembly 700 comprises a receiver/decoder unit 712, which receives signals from transmitter unit 102, and which, except as described hereinbelow, functions in a substantially similar manner and comprises substantially similar components as receiver assembly 104. On receipt of the signals, receiver unit 712 actuates a logic unit 714. Receiver assembly 700 is also able to transmit data from the unit, as described in more detail below. A power supply 716 receives power from a line source 718, and powers units 712 and 714.

Logic unit 714 controls the operation of a power switch 726 and a starter-replacement switch 720. Switches 726 and 720 are in series with device 706 and with both filaments of tube 702. Logic unit 714 also controls the operation of a controlled power

supply 724 which is coupled to source 718 via ballast 722 and device 706. Controlled power supply 724 most preferably comprises a detector 730, which is substantially similar in function to detector 516 described hereinabove.

In order to turn tube 702 "on" from an "off" state, receiver/decoder 712 receives a signal from transmitter unit 102 and actuates logic unit 714. Unit 714 ensures that in the "off" state both switches 720 and 726 are open. Logic unit 714 closes switch 726, and then operates switch 720 substantially as described above with reference to Fig. 7, utilizing detector 730 as necessary until the tube stays on. It will be appreciated that in this case switch 720 is open and 726 is closed.

In order to turn tube 702 "off" from an "on" state, receiver/decoder unit 712 receives a signal from transmitter unit 102 and opens switch 726.

Controlled power supply 724 is connected to tube 702 so that it is able to effectively act as a series and/or as a parallel electrical impedance relative to the tube. Furthermore, supply 724 measures and controls at least some of the electrical parameters comprised in the group current, voltage, frequency, duty cycle, pulse width and related electrical parameters of the power supplied to tube 702 and to the filaments of the tube. As is known in the art, when tube 702 is in an "on" state, variation of at least some of these parameters enables the tube to operate in one or more dimmed states and/or one or more reduced-energy dissipation states and/or one or more reduced light flashing states. Thus, supply 724 is used, responsive to signals received from transmitter unit 102 and received by receiver/decoder 712, to dim and/or save energy used by tube 702.

It will also be appreciated that supply 724, and/or unit 714, will be able to supply readouts of one or more operational parameters and states of tube 702 and elements coupled to the tube. Most preferably, values of the parameters and/or states are transmitted to a remote receiver, by methods known in the art, as is explained in more detail below. Furthermore, it will be appreciated that variation by supply 724 of at least some of the parameters listed above enables the supply to function in addition to, or as an alternative to switch 726. Thus, receiver assembly 700 can toggle tube 602 between an on state, an off state, one or more dim states, and one or more reduced-energy states. It will be understood that assembly 700 can be retrofitted to an existing fluorescent fitting, and/or installed in a new fitting.

Returning to Fig. 3, in some preferred embodiments of the present invention receiver assembly 104 comprises a detector 216, operating by methods known in the art such as measurement of circuit impedance, for monitoring a status of load 108. Detector 216,

preferably positioned close to load 108, monitors whether failure of the load to operate is due to failure of the load itself, or because the load is not inserted or is inserted incorrectly into its electrical sockets (all of which states, in the case of a lamp for example, are easily remedied). In these cases, receiver assembly 104 most preferably acts as a safety device by switch 204 disconnecting power source 206 from load 208, thereby preventing the possibility of electrocution during load replacement or insertion. Detector 216 preferably also monitors if failure of load 108 to operate is caused by a fault in circuitry between load 108 and source 206, which generally requires the attention of an electrician. In some preferred embodiments of the present invention, detector 216 transmits and/or indicates, by methods known in the art, one or more parameters indicative of the status of load 108 and/or receiver unit 104, hereinbelow referred to as the load. For example, detector 216 transmits a voltage across the load, a current drawn by the load, and/or a total time of operation of the load. Alternatively or additionally, the one or more parameters comprise parameters which may be used for maintenance and/or repair of the load. Such parameters may include measurements such as frequency of power applied to the load, temperature of the load, or other electrical or non-electrical parameters which affect the maintenance and/or repair of load 108 and/or receiver unit 104. Most preferably, the parameters are indicative of a status of the load, wherein the status comprises one or more of: a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load. The transmission from detector 216 is received by a parameter receiver 220 wherein preferably the one or more parameters are displayed, by methods known in the art.

It will be appreciated that receiver/decoder units 506 (Fig. 6), 612 (Fig. 9), and 712 (Fig. 10) may also comprise a detector which is implemented in substantially the same manner as, and performs substantially similar functions to, detector 216.

In some preferred embodiments of the present invention, receiver assembly 104 comprises a warning device 218, such as a light emitting diode (LED) which is able to generate a visible signal which may be used as a warning, and/or a piezoelectric vibrator which is able to generate an audible signal which may be used as a warning, and/or a radio-frequency (RF) generator which transmits an RF signal giving an indication of the status of

load 108. Device 218 is activated, by methods known in the art, preferably when load 108 has failed or exhibits a potential for failure. Alternatively or additionally, assembly 104 regulates the current through and/or voltage applied to load 108, by methods known in the art, in order to extend the life of the load. Further alternatively or additionally, assembly 104 adjusts a dim state and/or a flashing state of load 108, as applicable, by methods known in the art

It will be appreciated that in preferred embodiments of the present invention, where retrofitting receiver units described hereinabove does not require cutting into an existing electrical circuit, such as when the unit is inserted into an existing electrical socket or into an end of a fluorescent lamp socket, or when the unit replaces a starter of a fluorescent lamp, the installation may be performed by a layman.

It will also be appreciated that in preferred embodiments of the present invention, other forms of electrically excited gas tubes other than fluorescent tubes can be used. For example, tubes comprising neon, or other gases which radiate when electrically excited, can be operated in substantially the same manner as described above for fluorescent tubes.

It will further be appreciated that some preferred embodiments of the present invention may comprise one transmitter operating one or more receiver assemblies. For example, a separate receiver unit may be attached to each of a group of fluorescent lamps in a room or a building, as described hereinabove, and each of the lamps may be activated substantially simultaneously from one transmitter.

It will thus be appreciated that the preferred embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not disclosed in the prior art.

CLAIMS

1. An electrical switching system, comprising:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a non-incandescent load remote from the transmitting unit, so as to toggle the load between a plurality of states responsive to the actuating signal.

2. A system according to claim 1, wherein the transmitting unit is mounted in a fixed position.

3. A system according to claim 1, wherein the transmitting unit comprises a mobile transmitting unit.

4. A system according to claim 1, wherein the transmitting unit comprises a plurality of transmitting units, at least some of which are mounted in fixed positions.

5. A system according to claim 1, wherein the actuating signal comprises an electromagnetic signal.

6. A system according to claim 1, wherein the actuating signal comprises an acoustic signal.

7. A system according to claim 1, wherein the actuating signal comprises one or more codes, and wherein the receiver assembly comprises a decoder which decodes the one or more codes so as to toggle the load.

8. A system according to claim 7, wherein the decoder comprises a memory which stores the one or more codes of the actuating signal.

9. A system according to claim 8, wherein the decoder comprises a learning module which, responsive to the actuating signal, stores the one or more codes in the memory.

10. A system according to claim 1, wherein the transmitting unit comprises one or more power sources selected from a group consisting of a battery, a mains power supply, a piezoelectric film, a piezoelectric crystal, an electrical induction device, a static electricity device, capacitative charge from an operator of the transmitting unit, and a mechanically operated dynamo, and wherein the one or more power sources power the transmitting unit.

11. A system according to claim 1, wherein the non-incandescent load comprises

circuitry coupling the load to a power source.

12. A system according to claim 11, wherein the circuitry comprises a circuit element selected from a group consisting of a cable coupled to the load, a socket coupled to the cable, a plug coupled to the socket, and a switch coupled to the cable.

13. A system according to claim 1, wherein the non-incandescent load comprises a fluorescent lamp, wherein the fluorescent lamp comprises a lamp accessory selected from a group consisting of one or more sockets, a starter, and a ballast, and wherein the receiver assembly is retrofitted to the lamp accessory.

14. A system according to claim 13, wherein the receiver assembly is adapted to generate a voltage to start the fluorescent lamp.

15. A system according to claim 13, wherein the receiver assembly is adapted to short-circuit the lamp accessory, so as to switch off the fluorescent lamp.

16. A system according to claim 1, wherein the non-incandescent load comprises at least one load selected from a group consisting of a fluorescent lamp, a reactive device, and a resistive device.

17. A system according to claim 1, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

18. An electrical switching system, comprising:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a load remote from the transmitting unit so as to toggle the load between a plurality of states responsive to the actuating signal, and which is adapted to detect a status of the load and to provide an indication of the status to the user.

19. A system according to claim 18, wherein the status of the load comprises a state selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of

power to the load, a duty cycle of power to the load, and a pulse width of power to the load, and wherein the receiver assembly is adapted to adjust a power source to the load responsive to the state.

20. A system according to claim 18, wherein the load comprises circuitry coupling the load to a power source, and wherein the status of the load comprises a fault in the circuitry.

21. A system according to claim 18, wherein the receiver assembly comprises a sound-emitting device, and wherein the indication is an audible warning generated by the device.

22. A system according to claim 18, wherein the receiver assembly comprises a light-emitting device, and wherein the indication is a visible warning generated by the device.

23. A system according to claim 18, wherein the receiver assembly comprises a radio-frequency (RF) transmitter which transmits an RF signal indicative of the status of the load.

24. A system according to claim 18, wherein the receiver assembly comprises a detector which is adapted to transmit to the user one or more parameters selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

25. A system according to claim 18, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

26. An electrical switching system, comprising:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be retrofitted to a load remote from the transmitting unit so as to toggle the load between a plurality of states responsive to the actuating signal, and which is adapted to detect a status of the load and to alter a parameter of electrical power supplied to the load responsive to the status.

27. A system according to claim 26, wherein the status of the load comprises a change in status of the load, and the parameter of electrical power comprises either a current

through the load or a voltage across the load, which parameter is regulated.

28. A system according to claim 26, and comprising regulating the parameter so as to lengthen a lifetime of the load.

29. A system according to claim 26, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

30. A method for switching an electrical system, comprising:

retrofitting a receiver assembly to circuitry comprising a non-incandescent load;

transmitting an actuating signal receivable by the receiver assembly from a transmitting unit remote from the receiver assembly; and

toggling the load between a plurality of states responsive to the actuating signal.

31. A method according to claim 30, wherein the transmitting unit is mounted in a fixed position.

32. A method according to claim 30, wherein the transmitting unit is mobile.

33. A method according to claim 30, wherein the transmitting unit comprises a plurality of transmitting units, at least some of which are mounted in fixed positions.

34. A method according to claim 30, wherein transmitting the actuating signal comprises transmitting an electromagnetic signal.

35. A method according to claim 30, wherein transmitting the actuating signal comprises transmitting an acoustic signal.

36. A method according to claim 30, wherein transmitting the actuating signal comprises transmitting one or more codes, and wherein toggling the load comprises decoding the one or more codes.

37. A method according to claim 36, wherein retrofitting the receiver assembly comprises providing a memory in the receiver assembly and storing the one or more codes in the memory.

38. A method according to claim 37, wherein storing the one or more codes comprises learning the one or more codes responsive to the actuating signal.

39. A method according to claim 30, wherein transmitting the actuating signal comprises powering the transmitting unit from one or more power sources selected from a

group consisting of a battery, a mains power supply, a piezoelectric film, a piezoelectric crystal, an electrical induction device, a static electricity device, capacitative charge from an operator of the transmitting unit, and a mechanically operated dynamo.

40. A method according to claim 30, wherein the circuitry comprises a circuit element selected from a group consisting of a cable coupled to the load, a socket coupled to the cable, a plug coupled to the socket, and a switch coupled to the cable.

41. A method according to claim 30, wherein the non-incandescent load comprises a fluorescent lamp, wherein the fluorescent lamp comprises a lamp accessory selected from a group consisting of one or more sockets, a starter, and a ballast, and wherein retrofitting the receiver assembly comprises retrofitting the unit to the lamp accessory.

42. A method according to claim 41, wherein toggling the load comprises generating a voltage to start the fluorescent lamp.

43. A method according to claim 41, wherein toggling the load comprises short-circuiting the lamp accessory, so as to switch off the fluorescent lamp.

44. A method according to claim 30, wherein the non-incandescent load comprises at least one load selected from a group consisting of a fluorescent lamp, a reactive device, and a resistive device.

45. A method according to claim 30, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

46. A method for controlling an electrical system, comprising:

retrofitting a receiver assembly to circuitry comprising a load;

transmitting an actuating signal receivable by the receiver assembly from a transmitter remote from the receiver assembly;

toggling the load between a plurality of states responsive to the actuating signal;

detecting a status of the load; and

providing an indication of the status to a user.

47. A method according to claim 46, wherein detecting the status of the load comprises detecting a state selected from a group consisting of a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the

load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load, and wherein toggling the load comprises adjusting a power source to the load responsive to the detected state.

48. A method according to claim 46, wherein detecting the status comprises detecting a fault in the circuitry.

49. A method according to claim 46, wherein the receiver assembly comprises a sound-emitting device, and wherein providing the indication comprises generating an audible warning from the device.

50. A method according to claim 46, wherein the receiver assembly comprises a light-emitting device, and wherein providing the indication comprises generating a visible warning from the device.

51. A method according to claim 46, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

52. A method for controlling an electrical system, comprising:

retrofitting a receiver assembly to circuitry comprising a load;

transmitting an actuating signal receivable by the receiver assembly from a transmitter remote from the receiver assembly;

toggling the load between a plurality of states responsive to the actuating signal;

detecting a status of the load; and

altering a parameter of electrical power supplied to the load responsive to the status.

53. A method according to claim 52, wherein detecting the status of the load comprises detecting a change in status of the load, and wherein altering the parameter of electrical power comprises regulating a current through the load.

54. A method according to claim 52, wherein detecting the status of the load comprises detecting a change in status of the load, and wherein altering the parameter of electrical power comprises regulating a voltage across the load.

55. A method according to claim 52, wherein altering the parameter comprises regulating the parameter so as to lengthen a lifetime of the load.

56. A method according to claim 52, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

57. An electrical switching system, comprising:

a transmitting unit which is adapted to transmit an actuating signal responsive to actuation of the transmitting unit by a user; and

a receiver assembly, which is configured to be coupled to a load comprising an electrically excitable gas remote from the transmitting unit, so as to toggle the load between a plurality of states responsive to the actuating signal.

58. A system according to claim 57, wherein the load comprises a fluorescent tube within which the electrically excitable gas is contained.

59. A system according to claim 58, wherein the receiver assembly is coupled to the fluorescent tube as a replacement for a starter of the fluorescent tube.

60. A system according to claim 58, wherein the receiver assembly comprises a switch, and wherein the receiver assembly is adapted to toggle the load by operating the switch so as to short-circuit the fluorescent tube.

61. A system according to claim 58, wherein the receiver assembly comprises a switch and a detector which detects one or more electrical parameters preventing the fluorescent tube from starting, and wherein the receiver assembly is adapted to operate the switch when the detector indicates that the one or more electrical parameters will not cause the tube to start.

62. A system according to claim 61, wherein the one or more electrical parameters comprise a voltage across the switch being approximately zero volts.

63. A system according to claim 58, wherein the receiver assembly comprises a switch and a detector which detects one or more electrical parameters which start the fluorescent tube, and wherein the receiver assembly is adapted to operate the switch when the detector indicates that the one or more electrical parameters will cause the tube to start.

64. A system according to claim 63, wherein the one or more electrical parameters comprise a voltage across the switch being approximately a maximum voltage received from a power supply.

65. A system according to claim 58, wherein the fluorescent tube comprises a heating

filament and a starter, and wherein the receiver assembly is coupled to the heating filament.

66. A system according to claim 65, and wherein the starter is replaced by a device adapted to act as a short-circuit of the fluorescent tube.

67. A system according to claim 57, wherein the plurality of states comprise two or more states chosen from a group consisting of an "on" state, an "off" state, one or more dim states, one or more reduced light flashing states, and one or more reduced-energy states.

68. A system according to claim 57, wherein the receiver assembly comprises a status transmitter unit which is able to transmit parameters corresponding to a status of the receiver assembly.

69. A system according to claim 68, wherein the status comprises one or more parameters selected from a group comprising a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

70. A system according to claim 57, wherein the receiver assembly comprises a status transmitter unit which is able to transmit parameters corresponding to a status of the load.

71. A system according to claim 70, wherein the status comprises one or more parameters selected from a group comprising a failure of the load, a potential failure of the load, an incorrect insertion of the load into a socket, an absence of the load from the socket, a peak demand of the load, an average demand of the load, a current through the load, a voltage across the load, a resistance of the load, a temperature of the load, a power factor of the load, a power factor correction of the load, a time of operation of the load, a frequency of power to the load, a duty cycle of power to the load, and a pulse width of power to the load.

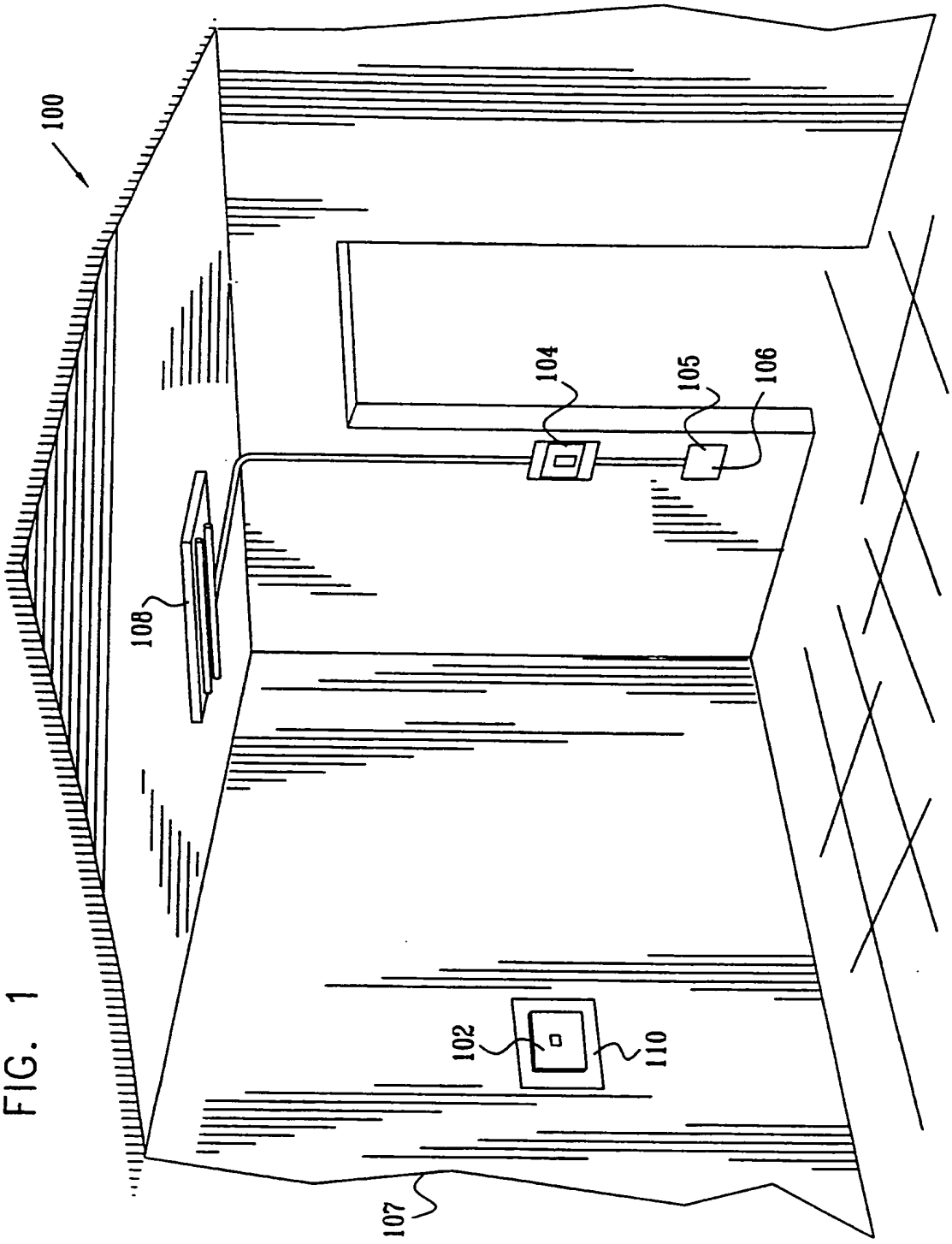


FIG. 1

FIG. 2

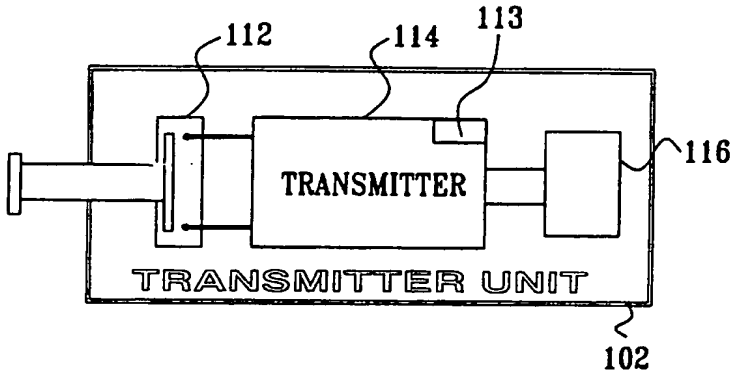

112
114
113
116
TRANSMITTER
TRANSMITTER UNIT
102

FIG. 3

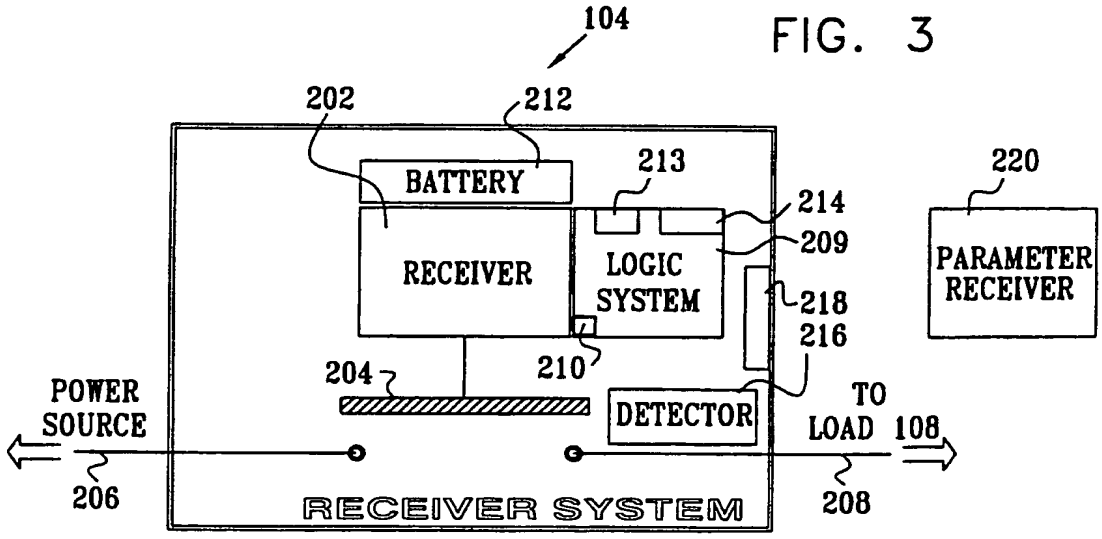

104
202
212
213
220
BATTERY
214
209
RECEIVER
LOGIC SYSTEM
PARAMETER RECEIVER
218
216
204
210
POWER SOURCE
DETECTOR
TO LOAD 108
206
208
RECEIVER SYSTEM

FIG. 4

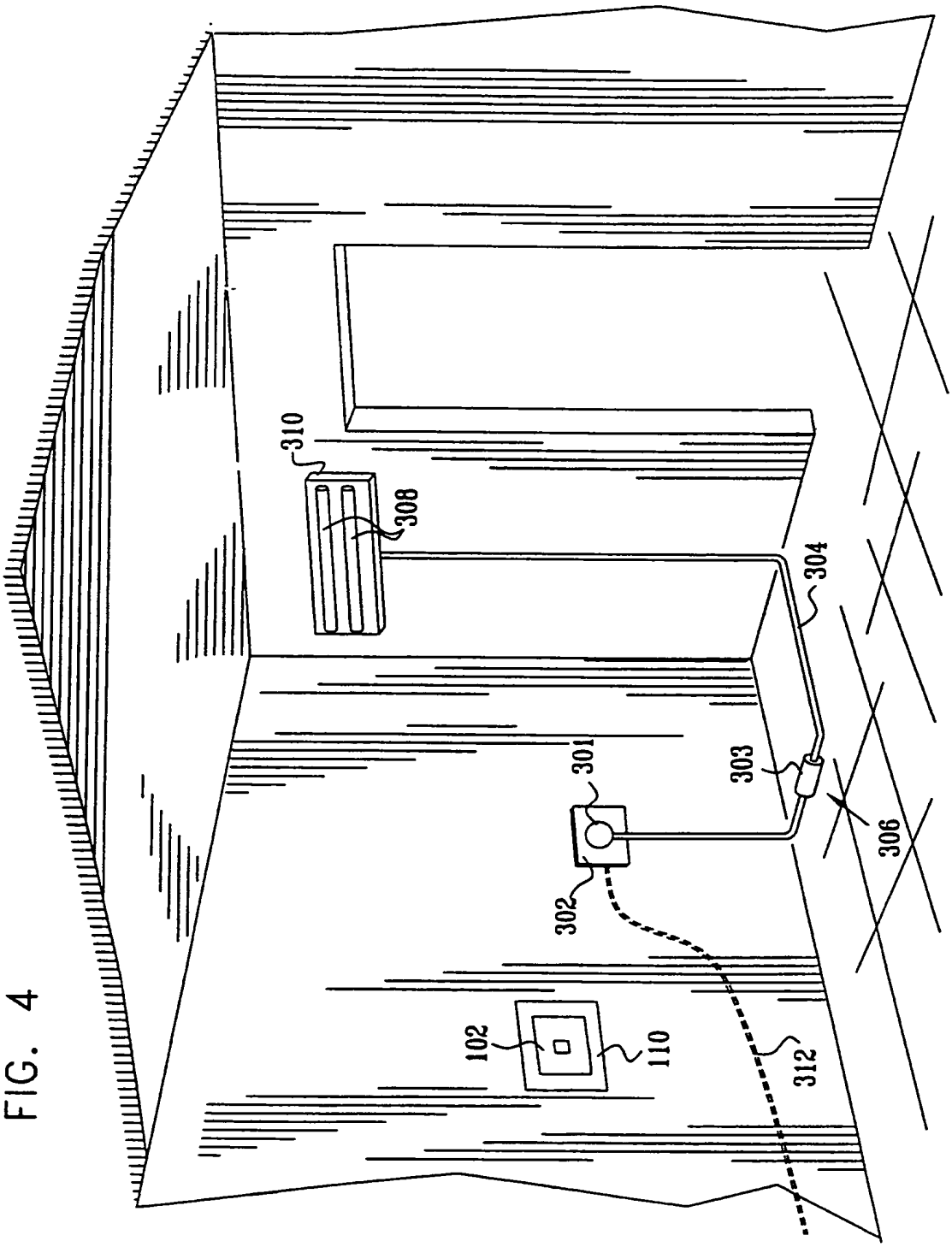


FIG. 5

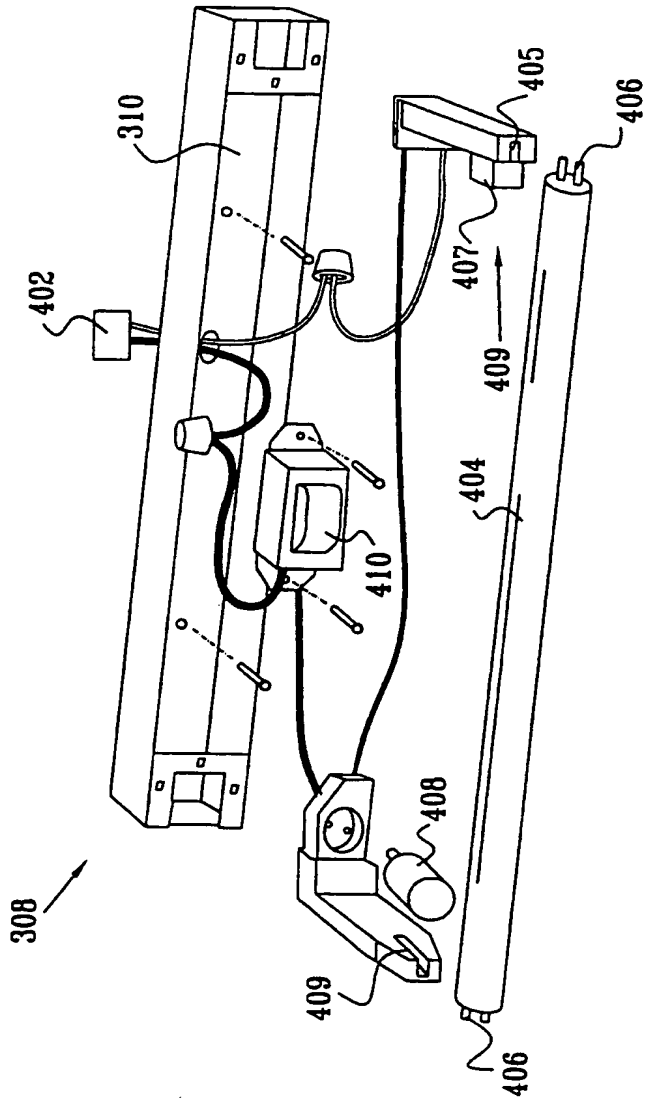


FIG. 6

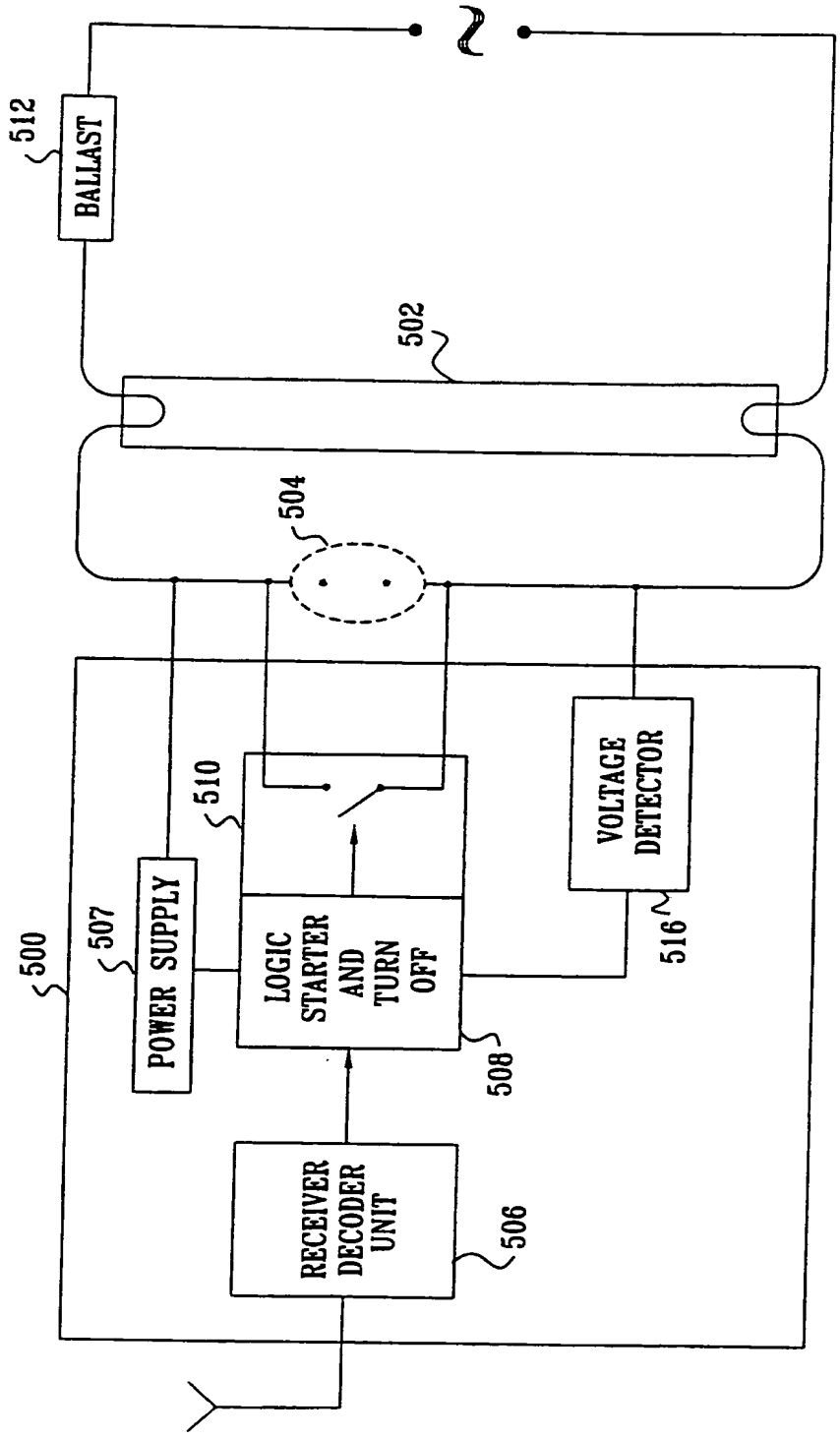

512
BALLAST
502
504
510
500
507
POWER SUPPLY
LOGIC STARTER AND TURN OFF
508
VOLTAGE DETECTOR
516
RECEIVER DECODER UNIT
506

FIG. 7

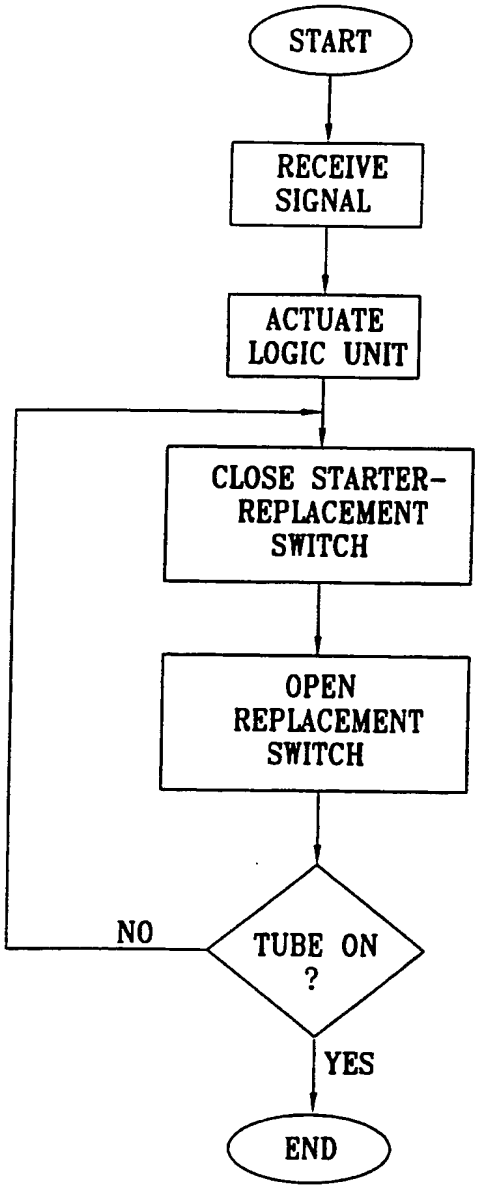
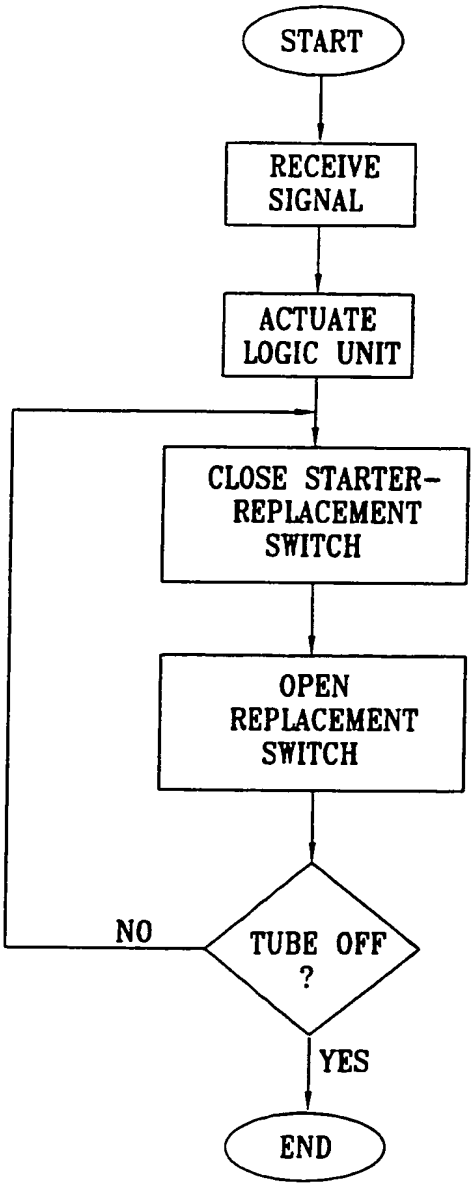

START
RECEIVE SIGNAL
ACTUATE LOGIC UNIT
CLOSE STARTER-REPLACEMENT SWITCH
OPEN REPLACEMENT SWITCH
TUBE ON ?
NO
YES
END

FIG. 8


START
RECEIVE SIGNAL
ACTUATE LOGIC UNIT
CLOSE STARTER-REPLACEMENT SWITCH
OPEN REPLACEMENT SWITCH
TUBE OFF ?
NO
YES
END

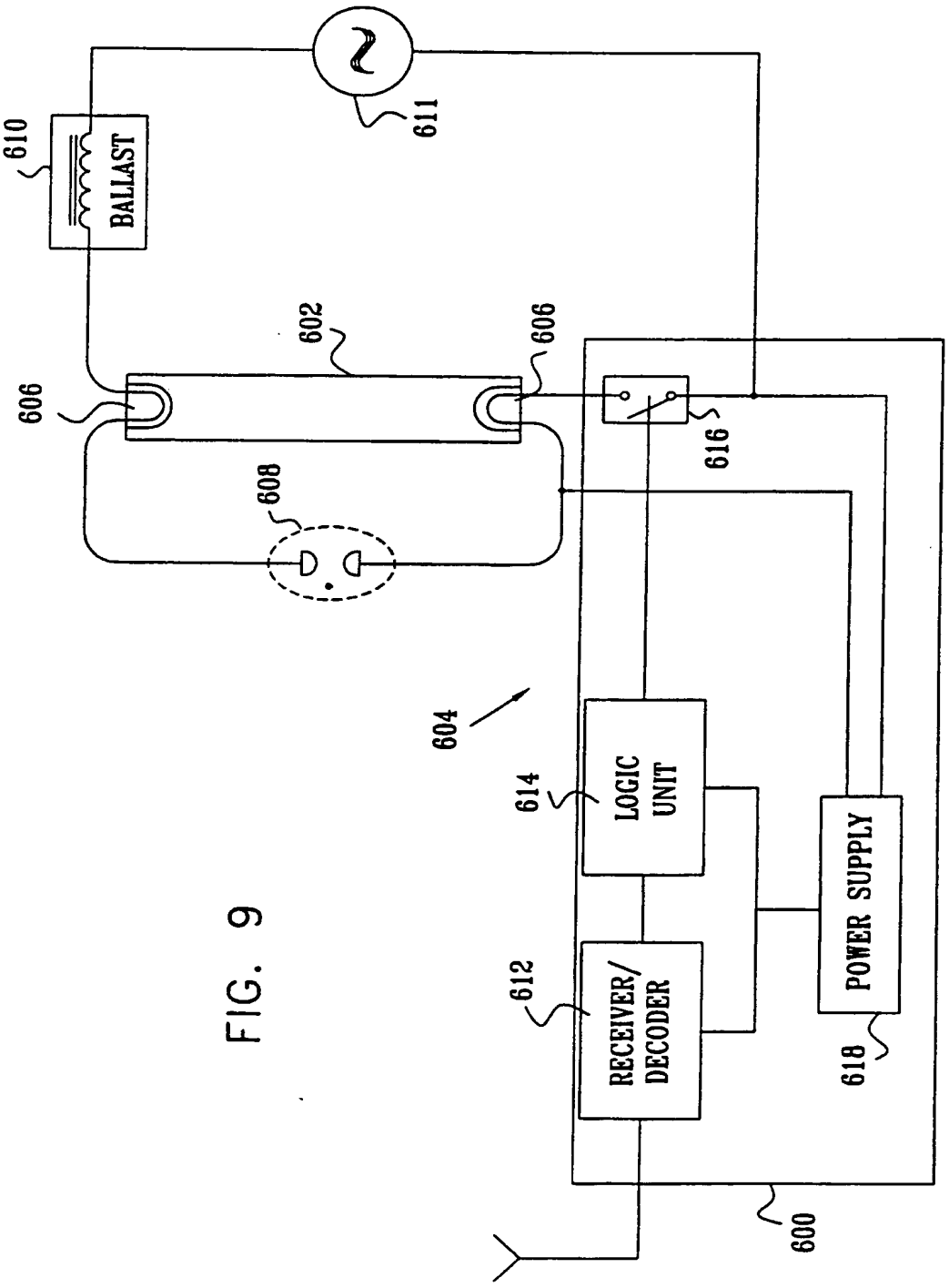

610
BALLAST
611
602
606
606
608
616
604
614
LOGIC UNIT
612
RECEIVER/ DECODER
POWER SUPPLY
618
600

FIG. 9

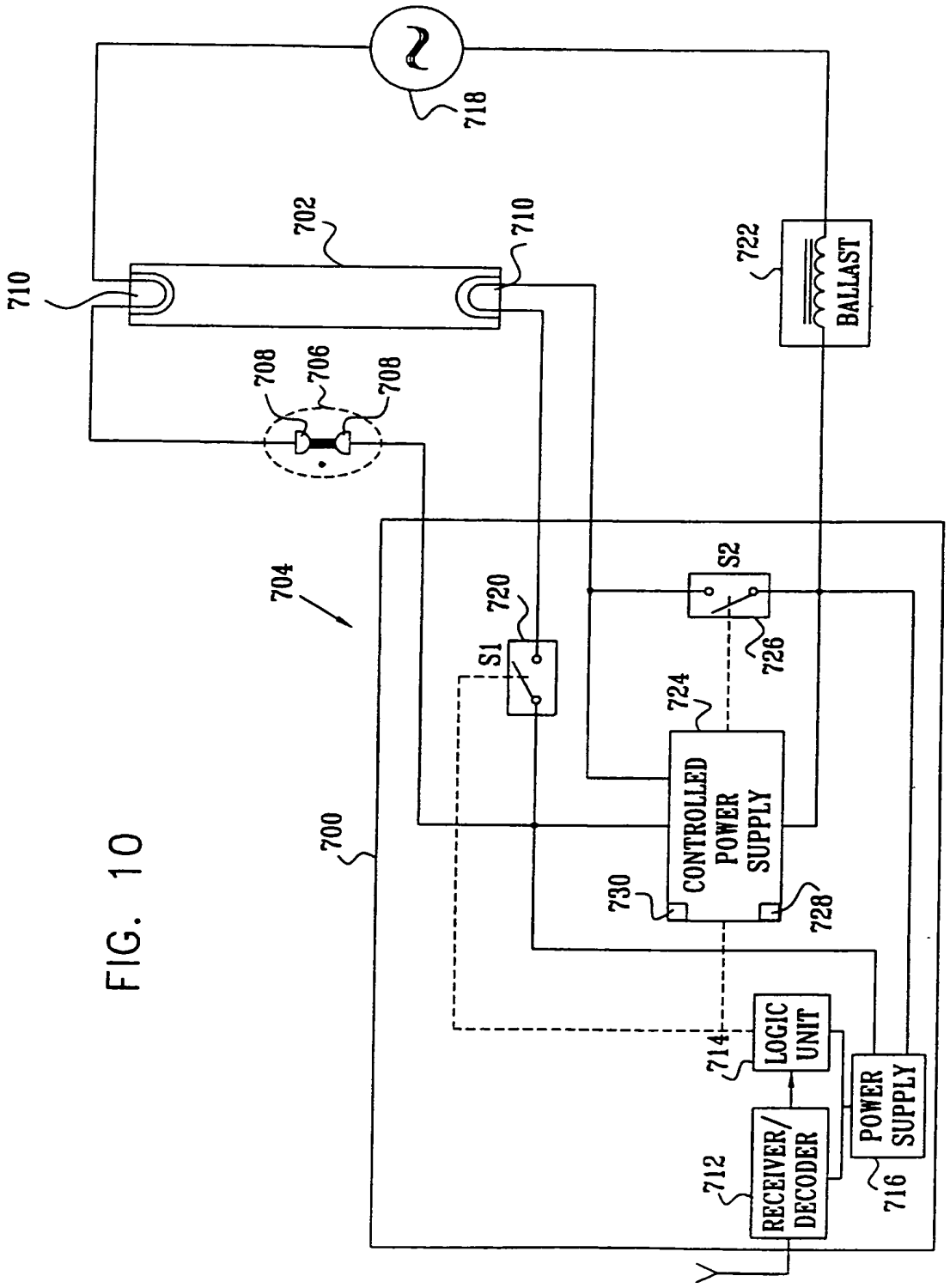

718
702
710
710
722
BALLAST
708
706
708
704
720
S1
S2
726
724
CONTROLLED POWER SUPPLY
700
730
728
LOGIC UNIT
714
RECEIVER/ DECODER
712
POWER SUPPLY
716

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL00/00692

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :G05F 1/00; H05B 37/02; H01H 3/00
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 315/295, 149, 158, 321, DIG.4, 315, 294, 319, 318, 362, 312, 250, 292, 320, 297, 307, 322

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,637,964 A (HAKKARAINEN et al) 10 June 1997 (10.06.1997), entire document.	1-71
Y	US 4,912,376 A (STRICK) 27 March 1990 (27.03.1990), entire document.	1-71

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 FEBRUARY 2001	22 MAR 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer CHUC TRAN Telephone No. (703) 306-5984

Form PCT/ISA/210 (second sheet) (July 1998) ★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL00/00692

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

315/295, 149, 158, 321, DIG.4, 315, 294, 319, 318, 362, 312, 250, 292, 320, 297, 307, 322